The Satellite Passive-Microwave Record of Sea Ice in the Ross Sea since Late 1978

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Satellites have provided us with a remarkable ability to monitor many aspects of the globe day-in and day-out, and sea ice is one of numerous variables that by now have quite substantial satellite records. Passive-microwave data have been particularly valuable in sea ice monitoring, with a record that extends back to August 1987 on a daily basis (for most of the period), to November 1978 on an every-other-day basis (again for most of the period), and to December 1972 on a less complete basis.

For the period since November 1978, satellite-derived Ross Sea sea ice imagery is available at a spatial resolution of approximately 25 km. This allows good depictions of the seasonal advance and retreat of the ice cover each year, along with its marked interannual variability. The Ross Sea ice extent typically reaches a minimum of approximately 0.7×10^6 km^2 in February, rising to a maximum of approximately 4.0×10^6 km^2 in September, with much variability among years for both those numbers. The Ross Sea images show clearly the day-by-day activity in the seasonal opening of the Ross Sea polynya in the spring and early summer and how this varies greatly from year to year. Animations of the data help to highlight the dynamic nature of the Ross Sea ice cover.

The satellite data also allow calculation of trends in the ice cover over the period of the satellite record. Using linear least-squares fits, the Ross Sea ice extent increased at an average rate of $12{,}600 \pm 1{,}800$ km^2/yr between November 1978 and December 2007, with every month exhibiting increased ice extent and the rates of increase ranging from a low of $7{,}500 \pm 5{,}000$ km^2/yr for the February ice extents to a high of $20{,}300 \pm 6{,}100$ km^2/yr for the October ice extents. On a yearly average basis, for 1979-2007 the Ross Sea ice extent increased at a rate of 4.8 ± 1.6 %/decade.

Placing the Ross Sea in the context of the Southern Ocean as a whole, over the November 1978 – December 2007 period the Ross Sea had the highest rate of increase in sea ice coverage of any of five standard divisions of the Southern Ocean, although the Weddell Sea, Indian Ocean, and Western Pacific Ocean all also had sea ice increases, while only the Bellingshausen/Amundsen Seas experienced overall sea ice decreases. Overall, the Southern Ocean sea ice cover increased at an average rate of $10{,}800 \pm 2{,}500$ km^2/yr between November 1978 and December 2007, with every month showing positive values although with some of these values not being statistically significant. The sea ice increase since November 1978 was preceded by a sharp decrease in Southern Ocean ice coverage in the 1970s and is in marked contrast to the decrease in Arctic sea ice coverage that has occurred both in the period since November 1978 and since earlier in the 1970s. On a yearly average basis, for 1979-2007 the Southern Ocean sea ice extent increased at a rate of 1.0 ± 0.4 %/decade, whereas the Arctic ice extent decreased at the much greater rate of 4.0 ± 0.4 %/decade (closer to the %/decade rate of increase in the Ross Sea). Considerable research is ongoing to explain the differences.